Memorandum

To: Chris Hempleman
Cc: Dustin Bilhimer, Greg Pelletier, Kirk Sinclair, Lawrence Sullivan, Trevor Swanson, Karol Erickson
From: Mindy Roberts
Date: October 29, 2004
Subject: Deschutes River, Capitol Lake, Budd Inlet TMDL
Quarterly Progress Report #6 (July through September 2004)

Introduction

The Deschutes River, Capitol Lake, Budd Inlet, and tributaries were placed on the 1996 and/or 1998 Clean Water Act Section 303(d) list of impaired waters based on historical monitoring by several organizations. In total, 24 water bodies have water quality parameter levels that do not meet standards for at least one of the following: temperature, fecal coliform bacteria, dissolved oxygen, pH, nutrients, or fine sediment. The TMDL study began in March 2003 to assess the current condition of the water bodies and to identify and quantify factors contributing to the impairments. The previous quarterly progress reports (July 31, 2003; December 1, 2003; February 9, 2004; April 15, 2004; and August 30, 2004) summarized the results of the 2003 monitoring program and earlier 2004 results.

This memorandum summarizes the progress to date related to data collection and project communications. Data presented are provisional; data quality has not been checked.

Progress to Date

Temperature and Hydrogeology Data Collection

Ecology maintained the surface water temperature and piezometer network through September, when temperature monitoring was discontinued. Data are being compiled and will be summarized in the next quarterly report. Table 1 presents the nutrient levels in samples collected from four piezometers located within gaining reaches. Nitrate levels varied among stations. The highest groundwater nitrate levels were found at the Deschutes River at 860 Rd station. Detectable levels were also found at the Deschutes River at USGS gage and near the mouth of Percival Creek. Other water quality parameters, such as conductivity and dissolved oxygen, also varied among sites with some variation over time within a station.

Two seepage runs were completed on Percival Creek. Streamflows were measured at all of the stream temperature monitoring locations on each occasion. The Black Lake Ditch upper site measured July 14 was in the reach including the stormwater retention ponds and downstream of the deep glide at the upstream section of that reach. The Black Lake Ditch upper site measured September 8 was near the log weir upstream of the bridge of the Black Lake Ditch near Mottman Rd. The results are included in the Tables 2 and 3.

City of Olympia personnel conducted channel morphology surveys on Percival Creek in August 2004 as part of an independent habitat assessment. We will use this information to characterize Percival Creek channel structure for analytical purposes.

Conventional Water Quality Parameter Data Collection and Planning

Routine monitoring continued through September for fecal coliform, DO, pH, nutrients, and related parameters. Samples were collected from the Deschutes River, Capitol Lake, their tributaries, and tributaries to Budd Inlet twice monthly and analyzed for fecal coliform bacteria. Concentrations greater than 200/100 mL were found once during the three-month period in the Deschutes River at river miles 5.5, 9.2, 20.5, and 28.6; Percival Creek at the mouth; and Adams Creek at the mouth. Two samples each from Chambers Creek and Reichel Creek and three samples from Ellis Creek had concentrations over 200/100 mL. Levels are consistently elevated in Indian, Mission, and Moxlie Creeks. In addition, a highly concentrated source continued to contribute to levels near the head of Adams Creek. Table 4 presents the fecal coliform data collected from July through September 2004.

Nutrient samples were collected monthly from July through September. Table 5 presents the results along with alkalinity and TSS data. Total persulfate nitrogen (TPN) continue to exhibit a longitudinal gradient from 0.1 at 1000 Rd to 0.7 to 0.8 mg/L at Henderson Blvd and E Street, with nitrate plus nitrite constituting 50 to over 90% of the total. Ammonia levels are near or below the detection limit except for Ayer Creek and Capitol Lake in late August. The highest nitrogen levels continue to be found in Chambers Creek. Percival Creek nitrogen levels were somewhat elevated but lower overall than in the Deschutes system. Capitol Lake (railroad trestle and outlet) nitrogen concentrations are lower than Deschutes River concentrations.

Total phosphorus and orthophosphate show similar longitudinal trends in the Deschutes River, with levels generally increasing downstream from 0.01 to 0.02 mg/L for both; nearly all the phosphorus is in orthophosphate form. August levels remained constant at 0.02 mg/L throughout the system. Capitol Lake total phosphorus levels were similar to or slightly less than those in the Deschutes River, while orthophosphate concentrations decrease from those in the Deschutes River inflow. From 50 to 100 percent of the phosphorus is in the form of orthophosphate upstream of the E Street bridge, but within Capitol Lake most phosphorus is organic. Percival Creek phosphorus concentrations (0.03 to 0.04 mg/L) were higher than those in the Deschutes system. Ayer Creek and Reichel Creek had the highest phosphorus levels, mostly in the organic form, while Capitol Lake had high phosphorus levels in late August.

Organic carbon levels are relatively low throughout the Deschutes River system, and nearly all carbon is in the dissolved form. An exception occurred in late August at Vail Cutoff Rd and 1000 Rd, which coincided with an increase in TSS to 23 and 49 mg/L. Capitol Lake levels are approximately double those in the Deschutes inflow, with a higher proportion in the particulate form. Percival Creek organic carbon levels are higher than in the Deschutes River or Capitol Lake with most in dissolved form. As in the previous quarter, Reichel Creek had the highest carbon levels in the study area with most in dissolved form. Ayer Creek, Chambers Creek, and Spurgeon Creek had elevated levels in August, as did Capitol Lake.

Alkalinity levels in the Deschutes River continue to exhibit a weak longitudinal gradient. TSS levels ranged from <1 to 3 mg/L throughout most of the sites, although elevated levels occurred in late August upstream of Rainier, in Capitol Lake, and at 1000 Rd in July.

Table 6 presents dissolved oxygen results obtained from Winkler titrations of grab samples. Samples are collected during daylight hours and represent a mix of morning and afternoon results. Ayer Creek DO levels were well below the water quality standard of 8 mg/L. Reichel and Black Lake Ditch also exhibited levels <8 mg/L, while all other sites had higher DO levels. Capitol Lake DO levels were the greatest of all sites sampled and were highly supersaturated in August, reaching 20 mg/L.

Ayer Creek had pH levels close to or less than 6.5 for the entire quarter, as shown in Table 7. One of the readings in Reichel Creek was less than 6.5 as well. Capitol Lake and Black Lake Ditch at the lake outlet consistently exceeded 8.5 SU. Peak grab sample values in Capitol Lake reached 9.8 SU and coincided with highly supersaturated DO levels.

Productivity Surveys

In addition to the monthly *in situ* samples, we deployed Hydrolabs at six locations within the Deschutes River watershed and Capitol Lake during a period of dry weather and low flows. Figure 1 presents temperature, dissolved oxygen, pH, and specific conductance results for each station. The temperature reached 20.05°C with a diel range of 3.5°C. Minimum dissolved oxygen levels reached 7.5 mg/L in the early morning with a diel range of 2.4 mg/L. The pH also exhibited daily variation, ranging from 7.1 to 7.6 SU. Table 8 summarizes the minimum and maximum values, as well as the daily range, for temperature, dissolved oxygen, and pH at each of the six stations.

City of Olympia staff conducted a dry-weather fecal coliform survey July 26-27, 2004 in the Indian, Mission, and Moxlie Creek watersheds. Samples were analyzed by Thurston County's laboratory, and the results are presented in Table 9. Most of the locations coincided with the planned Ecology monitoring locations presented in Figure 2. A high-level source exists in the headwaters of the Indian Creek system, but these levels appear to be diluted downstream of Martin Way and remain constant to the confluence with Moxlie Creek. Moxlie Creek concentrations are elevated within the buried sections. Mission Creek levels are elevated at the headwaters and decrease in concentration downstream, likely due to dilution by groundwater inflows.

Capitol Lake Surveys

One-day surveys of Capitol Lake were conducted from July through September. Table 10 includes nutrient and chlorophyll results for Capitol Lake (CL) stations from the summer surveys. Station locations are shown in Figure 3. Nitrogen and phosphorus levels generally decline from the south basin to the middle and north basins, while chlorophyll levels increase.

Table 11 presents profiles of temperature, pH, and dissolved oxygen. Specific conductance values indicate a pool of brackish water near the lake outlet and in the thalweg between the north and middle basins. Within this water, pH is neutral but dissolved oxygen levels are very low (generally <1 mg/L). Dissolved oxygen was slightly supersaturated during the survey, which did not coincide with expected peak late-afternoon DO levels. However, surface levels were greater than 110 percent saturation even during mid-day during the July and August surveys.

Figure 4 presents profiles of light within Capitol Lake, while Table 12 summarizes Secchi depth and grab samples of DO. The high light attenuation resulted from the high-productivity water column.

In addition to the short-term surveys, Ecology staff deployed a HydroLab near the outlet of Capitol Lake (located at a depth of 1 m approximately 10 m from the dam) from July 12 through August 13, 2004. Figure 5 presents the continuous temperature, dissolved oxygen, pH, and specific conductance data as well as the instantaneous Winkler titrations of dissolved oxygen.

Spikes in specific conductance coincide with high tides in Budd Inlet, and the figure indicates that marine waters are entering Capitol Lake during high tides. No spikes occurred the week of

the herbicide application, likely because the gates were closed and no water exchange occurred. Because the magnitude of the high tides was similar during the closed-gate period but no spikes in specific conductance occurred, the marine water is not entering as leakage around the gates but as overflow. The pulse of marine water also manifests itself in cooler temperature, lower pH, and lower dissolved oxygen levels.

Figure 6 summarizes the daily minimum and maximum dissolved oxygen levels. The diel variation ranges from 0.9 to 7.0 mg/L and indicates high productivity within the lake. The highest DO concentration recorded is 200% of the saturation value and coincides with the highest pH level recorded (10.55 SU).

Travel Time Survey

The low-flow travel time survey on the Deschutes River was conducted between August 2-6, 2004, when discharge at the USGS gage at Rainier ranged from 27 to 30 cfs. The river was segmented into four study reaches of approximately ten miles, with rhodamine (WT) dye released at the upstream extent and dye concentration monitoring at three to four locations downstream. Three of the four reaches were completed, and travel time data are presented in Table 13 for the Deschutes River between Vail Cutoff Rd and the E Street Bridge. During low-flow conditions, water travels from Vail Cutoff Rd to the E Street Bridge, a distance of approximately 28.1 miles, in 75.8 hours at an average velocity of 0.54 ft/s. Velocities within reaches between monitoring locations are uniform, ranging from 0.2 to 0.7 ft/s.

The upstream reach between the upper falls to Vail Cutoff Rd could not be monitored due to the unexpected rain storm that occurred on August 6. The study required a steady-state hydrologic regime and the precipitation in the watershed doubled flows reported for the USGS gage near Rainier.

Capitol Lake Bathymetry Survey

The Capitol Lake bathymetric survey was conducted September 21, 2004. USGS and Ecology Shorelands and Environmental Assistance Program staff completed the surveys of the north and middle basins but could not access Percival Cove or the shallow south basin. Echosounders mounted to wave runners with onboard gps navigation capabilities mapped the bottom. Aquatic weeds limited access in some areas and affected data quality in others. Figure 7 presents the preliminary bottom grid. Additional surveys are planned to fill in the data gaps using handheld gps units and depth rods.

In addition, the actual shoreline was mapped by kayak and a handheld Trimble gps unit (model GeoXT with sub-meter horizontal positioning) on September 23, 2004. Figure 8 presents the results.

Aquatic Plant Survey

Ecology staff surveyed the frequency and biomass of aquatic plants in Capitol Lake on July 11-12, 2004. Sites were randomly selected from a grid of the lake. Twelve aquatic plant species were found. Table 14 and Figure 9 summarize the data. The invasive Eurasian milfoil (*Myriophyllum spicatum*) was the dominant species by biomass and was also found in 44% of the points sampled. Following the herbicide application on July 19 and 29, 2004, milfoil frequency and biomass were significantly reduced. Waterweed (*Elodea*) was the most frequently found plant; its biomass increased following the herbicide application such that the overall plant biomass (65.3 g/m^2) did not change significantly following the application.

Benthic Flux Chambers

Benthic flux chambers were deployed in September. Temperature, dissolved oxygen, pH, and specific conductance were monitored continuously over two to three days in three chambers alternately placed throughout the north and middle basins. The data have not been compiled to date but will be presented in the next quarterly report.

Communication and Coordination

- Discussed nutrient data analysis from DFW's hatchery with Mary Evans in July.
- Met with Chris Hempleman and Perry Lund July 8 to discuss coordination of the TMDL and estuary feasibility study schedule.
- Mindy Roberts met with CLAMP Stormwater Technical Subcommittee on July 22, 2004 to exchange information on stormwater around Capitol Lake.
- Dustin Bilhimer, Erika Wittmann, and Mindy Roberts met with reporter and photographer from The Olympian on August 2, 2004, at the rhodamine dye release at Military Road for the time of travel study.
- Verified that GA personnel are recording Capitol Lake outlet operations as requested.
- Provided comments to Perry Lund on estuary feasibility study plan.
- Discussed fish mortality due to total dissolved gas with Joan Thomas (DFW).
- Provided Cameron Sharpe (DFW) with information regarding temperature and flow monitoring for his fisheries project.
- Reviewed Palermo Wellfield report forwarded by Kathy Callison regarding PCE and TCE discharges.
- Provided navigation tracklines for the bathymetric survey to USGS personnel.
- Provided Jim Erskine (GA) with information regarding the bathymetric survey in September.
- Borrowed SEA Program's Trimble gps unit from Perry Lund to map the Capitol Lake shoreline.
- Discussed Capitol Lake bathymetric data needs with Perry Lund to verify that the information meets the estuary feasibility study needs as well as the TMDL's needs.

Project Schedule and Upcoming Tasks

Monitoring during the period October through December includes continuing programs as well as short-term programs:

- Continue with routine monitoring for fecal coliform bacteria, nutrients, DO, pH, alkalinity, and pH.
- Decommission remaining piezometers.
- Track storms for potential wet-weather sampling events.
- Fill in gaps in bathymetric survey using handheld gps and depth rod.

We distributed the previous quarterly report via the Deschutes website in August 2004. The next quarterly report will be prepared and distributed in January 2005. Monitoring programs should conclude in December 2004 if the storm sampling is complete.

Tables and Figures

Table 1. Water quality and nutrient levels in piezometers within selected gaining reaches.

Station	Date	Field Parameters				Laboratory Analyses					
		Temp (C)	pH (SU)	Cond (µS/cm@25C)	DO (mg/L)	DOC (mg/L)	OP (mg/L)	TP (mg/L)	NO23N (mg/L)	NH3N (mg/L)	DTPN (mg/L)
Deschutes at Vail Cutoff Rd	7/28/2004	10.7	6.93	185	0.2	1.0 U	0.008	0.116	0.01 U	0.130	0.140
	8/30/2004	11.2	6.88	187	<0.1	1.0 U	0.012	0.135	0.01 U	0.141	0.160
	9/28/2004	10.7	NR	187	<0.1	1.0	0.013	0.132	0.01 U	0.147	0.160
Deschutes at USGS gage near Rainier	7/28/2004	11.2	6.37	102	5.55	1.0 U	0.050	0.046	1.21	0.01 U	1.220
	8/30/2004	12.0	6.29	108	0.84	1.0 U	0.055	0.054	1.25	0.01 U	1.250
	9/28/2004	10.7	NR	107	4.71	1.0 U	0.053	0.050	1.25	0.01 U	1.210
Deschutes at 860 Rd	8/30/2004	10.2	6.36	185	4.07	1.0 U	0.053	0.051	4.76	0.01 U	4.700
	9/29/2004	10.2	NR	183	7.75	1.0 U	0.017	0.128	4.74	0.01 U	4.730
Deschutes at Military Rd	9/28/2004	13.4	NR	133	<0.1	1.2	0.056	0.067	0.01 U	0.036	0.064
Deschutes off Cowlitz Dr	8/30/2004	14.6	6.71	166	<0.1	1.0 U	0.029	0.089	0.01 U	0.032	0.051
Deschutes at Henderson Blvd	7/28/2004	11.6	7.17	179	0.19	1.0 U	0.086	0.128	0.01 U	0.193	0.220
	8/30/2004	12.1	7.13	176	<0.1	1.0 U	0.081	0.152	0.01 U	0.206	0.220
	9/28/2004	12.1	NR	174	<0.1	1.0 U	0.080	0.152	0.01 U	0.204	0.220
Percival near mouth	7/28/2004	10.8	7.11	147	0.87	1.0 U	0.055	0.050	0.395	0.01 U	0.403
	8/30/2004	11.9	7.02	151	<0.1	1.0 U	0.060	0.058	0.358	0.01 U	0.366
	9/28/2004	11.8	NR	152	<0.1	1.0 U	0.059	0.055	0.421	0.01 U	0.428

Table 2. Percival Creek seepage run conducted July 14, 2004.

Description	Time	Approx. RM	Wetted Width (ft)	Wetted Perimeter (ft)	Cross-sectional area (ft^2)	Avg. Depth (ft)	Avg. Velocity (ft/s)	Discharge (cfs)
Percival Creek at mouth	16:45	0.0	19.7	19.95	14.32	0.73	0.67	9.54
Percival Creek below BLD confluence	14:00	1.0	13.3	13.51	9.84	0.74	0.85	8.38
Percival Creek above BLD confluence	14:40	1.1	6.0	6.81	2.54	0.42	0.86	2.19
Percival Creek at SPSCC	16:00	2.0	7.2	7.30	4.10	0.57	0.64	2.60
Percival at Chaparrelle Rd	11:25	3.0	7.2	7.21	3.14	0.44	0.52	1.62
Percival at Sapp Rd	10:40	4.0	7.4	7.49	6.22	0.84	0.29	1.82
Percival at Trosper Rd	10:01	5.0	9.8	9.88	3.86	0.39	0.39	1.52
Black Lake Ditch upper site	12:55		12.8	13.44	8.31	0.65	0.63	5.25
BLD above confluence	15:08	1.1	12.8	13.42	7.12	0.56	0.81	5.78

Table 3. Percival Creek seepage run conducted September 8, 2004.

Description	Time	Approx. RM	Wetted Width (ft)	Wetted Perimeter (ft)	Cross-sectional area (ft^2)	Avg. Depth (ft)	Avg. Velocity (ft/s)	Discharge (cfs)
Percival Creek at mouth	13:55	0.0	14.8	14.93	8.32	0.56	1.03	8.59
Percival Creek below BLD confluence	12:15	1.0	12.9	13.98	10.55	0.82	0.71	7.48
Percival Creek at SPSCC	13:02	2.0	7.3	7.53	2.71	0.37	0.80	2.17
Percival at Chaparrelle Rd	9:54	3.0	8.4	8.56	1.56	0.19	1.17	1.83
Percival at Sapp Rd	9:20	4.0	8.1	8.59	4.21	0.52	0.47	1.99
Percival at Trosper Rd	8:48	5.0	9.7	10.08	3.10	0.32	0.39	1.20
Black Lake Ditch upper site	10:34		16.5	16.78	7.64	0.46	0.66	5.08
BLD above confluence	11:35	1.1	11.8	11.93	8.68	0.74	0.66	5.69

Table 4. Fecal coliform data collected between July and September 2004. Highlighted values are >200/100 mL.

Station	7/7/04	7/20/04	7/21/04	8/10/04	8/11/04	8/24/04	8/25/04	9/14/04	9/15/04	9/28/04	9/29/04
Mainstem Deschutes River											
13-DES-00.5	33	16		33		68		67		17	
13-DES-02.7	15	16		11			135	73			33
13-DES-05.5	41		160		34		210		110		36
13-DES-09.2	44		60		91		210		120		110
13-DES-20.5	36		31		13		380		71		49
13-DES-28.6	59		10		26		810		63		38
Deschutes River Tributaries											
13-AYE-00.0	15		75		37		180		26		7
13-CHA-00.1	47		110		92		650		390		17
13-HUC-00.3	5		5		5		100		34		6
13-REI-00.9	470		200		43		760		23		18
13-SPU-00.0	67		22		92		190		63		24
Capitol Lake, Percival Creek, and Tributaries											
13-BLA-00.0	20	22		19		36		19		8	
13-BLA-02.3	1	2		71		5		6		8	
13-PER-00.1	130	29		64		470		41		9	
13-PER-01.0	130	67		160		130		84		45	
13-CAP-00.4	28	8		1		7		7		1	
Budd Inlet Tributaries											
13-ADA-00.5	19	39		760		35		31		2	
13-ADA-UNK	12000	6700		77		12000		2400		1400	
13-BUT-00.1	80	95		130		64		34		6	
13-ELL-00.0	290	23000		150		300		160		23	
13-IND-00.2	1000	200		450		3700		670		1400	
13-MIS-00.1	240	160		250		680		300		170	
13-MOX-00.0	750	710		470		4600		260		180	
13-MOX-00.6	260	210		210		2000		270		120	
13-SCH-00.1	15					140		33			

Table 5. Nutrient, alkalinity, and TSS data collected between July and September 2004.

Date	Station	TPN (mg/L)	DTPN (mg/L)	NO23N (mg/L)	NH3 (mg/L)	TP (mg/L)	OP (mg/L)	TOC (mg/L)	DOC (mg/L)	ALK (mg/L)	TSS (mg/L)
7/20/04	13-BLA-02.3	0.210		<0.010	<0.010	0.0099	0.0039				
	13-CAP-00.0	0.140		<0.010	<0.010	0.0165	0.0049	1.9	1.6		3
	13-CAP-00.4	0.200		<0.010	<0.010	0.0176	0.0058	2.3	2.3		3
	13-DES-00.5	0.761		0.694	<0.010	0.0238	0.0170	1.1	<1.0	48.9	2
	13-DES-02.7	0.827		0.724	0.014	0.0244	0.0180	<1.0	<1.0	48.1	3
	13-PER-00.1	0.354		0.202	<0.010	0.0316	0.0210	3.0	2.8		2
	13-PER-01.0	0.598		0.452	<0.010	0.0390	0.0190				
7/21/04	13-AYE-00.0		0.240	<0.010	0.056	0.0913	0.0230	3.6	3.4		
	13-CHA-00.1		1.860	1.810	<0.010	0.0154	0.0140	1.7	1.3		
	13-DES-05.5		0.743	0.633	0.011	0.0153	0.0100	2.3	1.2	45.2	5
	13-DES-09.2		0.839	0.753	<0.010	0.0133	0.0098	1.1	<1.0	46.3	2
	13-DES-20.5		0.828	0.586	0.012	0.0141	0.0100	<1.0	<1.0	48.2	4
	13-DES-28.6		0.299	0.216	<0.010	0.0121	0.0059	1.1	<1.0	43.7	3
	13-DES-37.4		0.100	0.036	<0.010	0.0089	0.0091	<1.0	<1.0	41.3	16
	13-REI-00.9		0.130	0.014	<0.010	0.0494	0.0270	2.7	2.5		
	13-SPU-00.0		0.100	0.013	<0.010	0.0298	0.0230	1.9	1.9		
8/24/04	13-BLA-02.3	0.294	0.190	<0.010	0.024	0.0259	0.0053				
	13-CAP-00.0	0.350	0.210	0.067	<0.010	0.0486	0.0077	7.4	2.3		9
	13-CAP-00.4	0.500	0.339	0.142	0.127	0.0683	0.0390	2.7	2.0		3
	13-DES-00.5	0.716	0.665	0.640	<0.010	0.0263	0.0190	1.8	1.7	46.0	2
	13-PER-00.1	0.370	0.306	<0.010	<0.010	0.0389	0.0240	3.4	3.1		2
	13-PER-01.0	0.468	0.396	0.293	<0.010	0.0434	0.0210				
8/25/04	13-AYE-00.0	0.542	0.323	<0.010	0.091	0.1230	0.0334	6.1	5.4		
	13-CHA-00.1	1.480	1.370	1.250	<0.010	0.0314	0.0200	6.4	6.2		
	13-DES-02.7	0.788	0.777	0.740	0.011	0.0282	0.0200	2.2	2.0	43.0	4
	13-DES-05.5	0.725	0.730	0.676	0.012	0.0228	0.0150	2.3	2.3	41.0	4
	13-DES-09.2	0.801	0.836	0.788	0.014	0.0213	0.0130	1.8	1.8	41.0	7
	13-DES-20.5	0.391	0.424	0.360	<0.010	0.0271	0.0140	2.4	2.0	41.0	13
	13-DES-28.6	0.468	0.526	0.429	<0.010	0.0405	0.0140	4.2	4.2	33.0	49
	13-DES-37.4	0.548	0.593	0.524	<0.010	0.0256	0.0120	4.6	4.5	27.0	23
	13-REI-00.9	1.200	1.110	0.940	0.014	0.0826	0.0479	7.4	7.2		
	13-SPU-00.0	0.220	0.170	<0.010	<0.010	0.0430	0.0290	4.8	4.6		
9/28/04	13-BLA-02.3	0.414	0.262	0.045	0.085		0.0140				
	13-CAP-00.0	0.314	0.252	0.168	<0.010	0.0189	0.0060	2.6	1.9		4
	13-CAP-00.4	0.296	0.230	0.153	<0.010	0.0176	0.0060	2.6	1.9		5
	13-DES-00.5	0.659	0.644	0.595	<0.010	0.0202	0.0170	1.3	1.3	45.3	2
	13-PER-00.1	0.495	0.411	0.255	<0.010	0.0334	0.0200	4.2	3.8		3
	13-PER-01.0	0.574	0.511	0.398	<0.010	0.0339	0.0180				
9/29/04	13-AYE-00.0	0.374	0.220	0.031	0.072	0.0562	0.0230	3.4	3.0		
	13-CHA-00.1	2.460	1.860	1.890	<0.010	0.0156	0.0150	1.9	1.6		
	13-DES-02.7	0.684	0.675	0.602	0.014		0.0190	1.3	1.1	45.3	2
	13-DES-05.5	0.608	0.565	0.492	<0.010	0.0129	0.0097	1.3	1.4	42.2	3
	13-DES-09.2	0.641	0.550	0.549	<0.010	0.0121	0.0099	1.2	1.3	42.0	2
	13-DES-20.5	0.382	0.373	0.308	<0.010	0.0097	0.0088	1.3	1.3	40.5	1
	13-DES-28.6	0.190	0.170	0.130	<0.010	0.0066	0.0053	1.0	1.1	38.5	2
	13-DES-37.4	0.120	0.100	0.066	<0.010	0.0058	0.0075	1.2	1.2	35.1	<1
	13-REI-00.9	0.623	0.476	0.098	0.015	0.0611	0.0270	9.9	10.0		
	13-SPU-00.0	0.210	0.140	0.024	<0.010	0.0223	0.0180	3.2	3.0		

Table 6. Dissolved oxygen (Winkler titration) data collected between July and September 2004. Highlighted values are <8 mg/L.

Station	7/7/04	7/20/04	7/21/4	8/10/04	8/11/04	8/13/04	8/24/04	8/25/04	9/14/04	9/15/04	9/28/04	9/29/04
Mainstem Deschutes River												
Deschutes at 1000 Rd	9.98		9.42		9.47	9.61		9.72		10.39		10.87
Deschutes at Vail Cutoff Rd SE	10.25		9.83		9.38	8.30		9.30		9.65		10.93
Deschutes at Rte 507	10.10		9.80		9.60	8.75		9.26		10.14		10.65
Deschutes nr Rich Rd	9.55		9.36		9.15	8.98		8.80		9.91		10.50
Deschutes off Riverlea	9.23		9.22		8.98	9.10		8.72		9.68		10.10
Deschutes at Henderson	9.90	9.55		9.61				9.20	9.66			9.14
Deschutes at E St	10.20	10.20		10.00	9.81	9.54	9.28		9.77		10.33	
Upper Deschutes tributaries												
Huckle-berry	9.57		9.00		8.70			9.25		9.65		9.74
Reichel	7.32		6.58		5.40			6.09		5.63		4.72
Lower Deschutes Tributaries												
Spurgeon	9.35		8.90		8.76			8.15		9.15		9.81
Ayer	1.69		1.20		1.05			1.51		1.94		2.43
Chambers	9.48		9.21		8.90			8.34		8.74		9.18
Capitol Lake and tributaries												
Black Lake outlet	9.48	10.48		10.25			8.81		10.31		6.77	
Black Lake Ditch	7.78	7.87		8.12			8.10		8.13		8.48	
Percival nr Black Lk Ditch	9.85	9.30		9.20			9.15		9.65		10.20	
Percival nr mouth	9.00	8.55		8.73			8.80		9.05		9.40	
Capitol Lake at RR trestle	11.90	11.38		18.17			8.00		11.85		13.90	
Capitol Lake at outlet	11.71	11.39		18.48	20.01	17.39	11.95		11.50		13.95	

Table 7. pH data collected between July and September 2004. Highlighted values are <6.5 SU or >8.5 SU.

Station	7/7/04	7/20/04	7/21/04	8/10/04	8/11/04	8/13/04	8/24/04	8/25/04	9/14/04	9/15/04	9/28/04	9/29/04
Mainstem Deschutes River												
Deschutes at 1000 Rd	7.80		7.97		8.05	7.80		7.38		7.90		8.12
Deschutes at Vail Cutoff Rd SE	7.30		7.38		7.13	7.20		7.10		7.50		7.64
Deschutes at Rte 507	7.60		7.72		7.59	7.57		7.30		7.65		7.94
Deschutes nr Rich Rd	7.20		7.44		7.38	7.35		7.48		7.38		7.67
Deschutes off Riverlea	7.33		7.48		7.31	7.60		7.10		7.41		7.76
Deschutes at Henderson	7.39	7.39		7.46				7.08	7.76			7.32
Deschutes at E St	7.50	7.57		7.59	7.44	7.45	7.48		7.62		7.71	
Upper Deschutes tributaries												
Huckleberry	7.50		7.24		7.43			7.25		7.55		7.71
Reichel	7.10		7.18		7.12			6.80		6.43		6.83
Lower Deschutes Tributaries												
Spurgeon	7.40		7.59		7.46			7.29		7.41		7.75
Ayer	6.69		6.64		6.43			6.18		6.43		6.54
Chambers	7.09		7.34		7.23			7.10		7.37		7.40
Capitol Lake and tributaries												
Black Lake outlet	8.56	8.83		8.63			9.45		9.00		7.62	
Black Lake Ditch	7.42	7.35		7.43			7.15		7.45		7.78	
Percival nr Black Lk Ditch	7.65	7.56		7.60			7.45		7.70		7.99	
Percival nr mouth	7.85	7.55		7.85			7.24		7.73		8.00	
Capitol Lake at RR trestle	8.69	8.90		9.70			8.50		9.26		9.55	
Capitol Lake at outlet	9.34	9.14		9.69	9.83	9.82	9.29		9.21		8.78	
Budd Inlet Tributaries												
Adams at Boston Harbor Rd	6.71	7.00		6.88			6.70		6.85		7.28	
Adams upstream	7.41	7.26		7.34			7.08		7.19		7.80	
Butler	7.61	7.50		7.94			7.56		7.61		7.99	
Ellis	7.42	7.29		7.39			7.42		7.35		7.81	
Indian	7.49	7.39		7.52			7.47		7.46		7.91	
Mission	7.41	7.26		7.30			6.95		7.34		7.80	
Moxlie at Plum St	7.37	7.38		7.60			7.28		7.52		7.86	
Schneider	7.62						7.40		7.76			

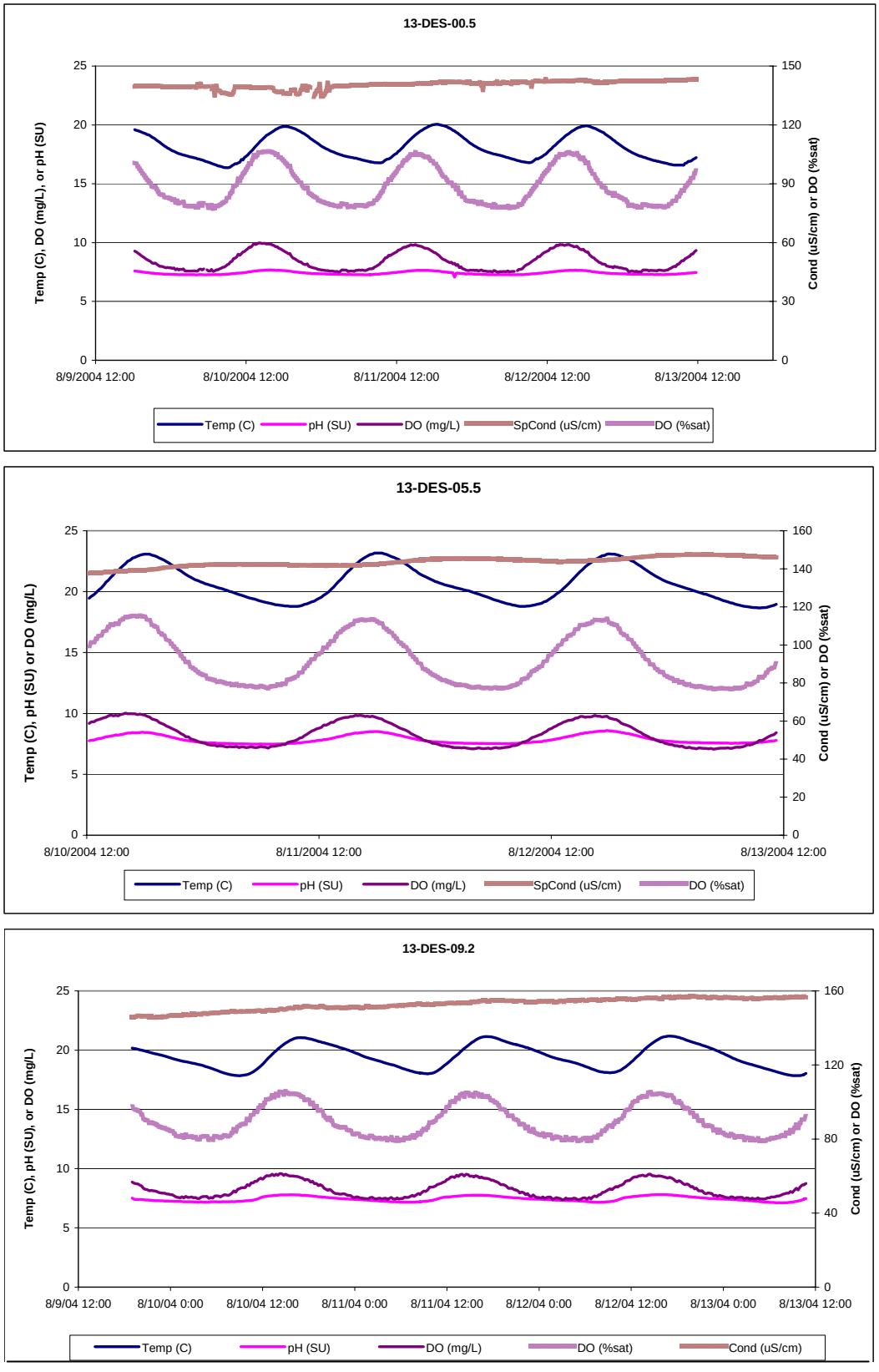


Figure 1. Continuous temperature, pH, dissolved oxygen, and specific conductance in the Deschutes River and Capitol Lake.

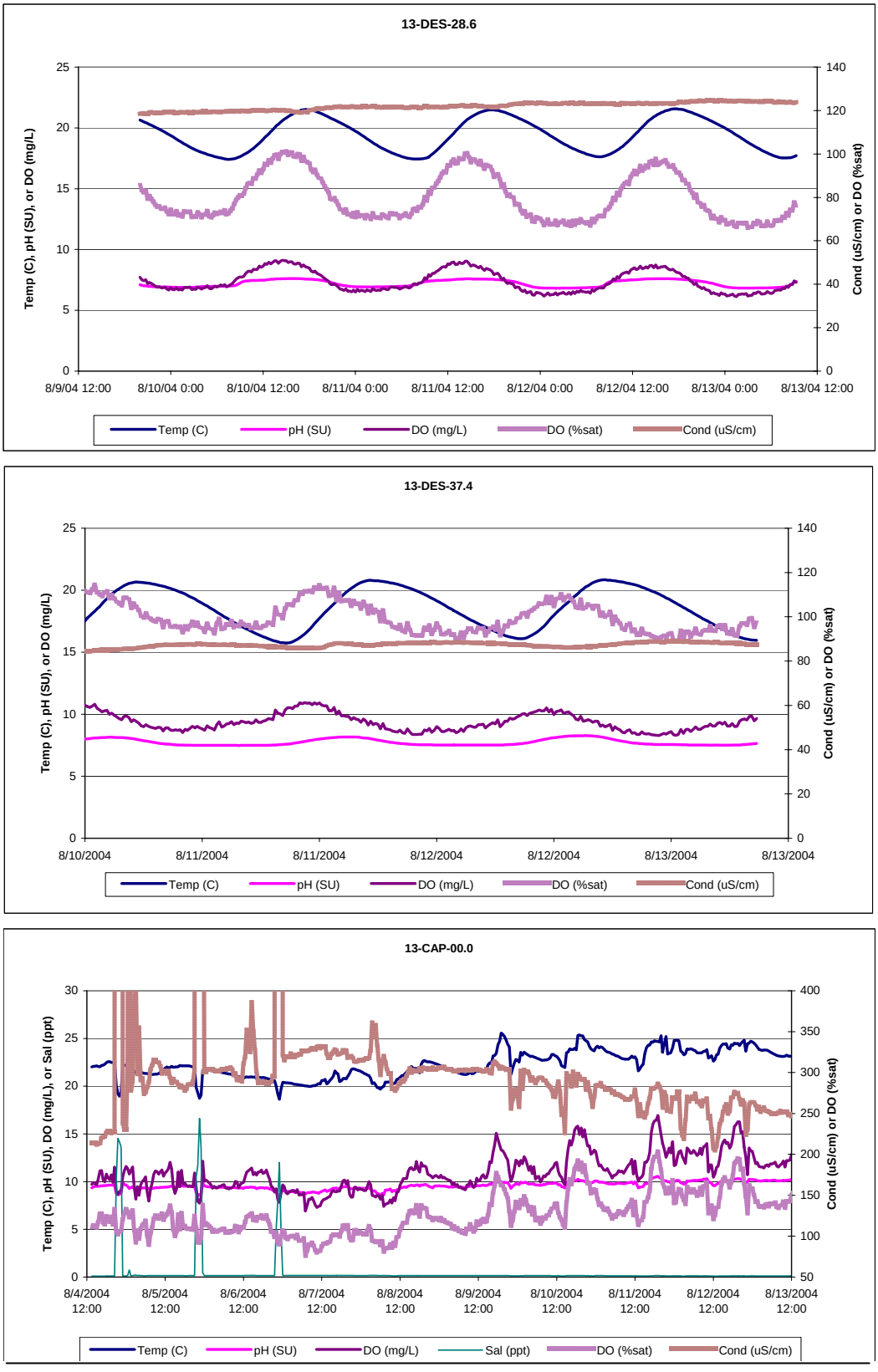


Figure 1 (cont'd). Continuous temperature, pH, dissolved oxygen, and specific conductance in the Deschutes River and Capitol Lake.

Table 8. Hydrolab data summary for Deschutes River productivity surveys.

Date	T (C)			DO (mg/L)			DO (%sat)		pH (SU)		
	Min	Max	Delta	Min	Max	Delta	Min	Max	Min	Max	Delta
13-DES-00.5											
8/9/04	17.97	19.60	1.63	7.86	9.28	1.42	82.7	100.8	7.31	7.58	0.27
8/10/04	16.36	19.87	3.51	7.55	9.97	2.42	77.3	106.6	7.26	7.67	0.41
8/11/04	16.78	20.05	3.27	7.51	9.83	2.32	78.2	105.9	7.05	7.65	0.60
8/12/04	16.80	19.93	3.13	7.49	9.85	2.36	77.7	106.2	7.27	7.66	0.39
8/13/04	16.58	18.14	1.56	7.51	9.33	1.82	77.9	96.6	7.29	7.46	0.17
13-DES-05.5											
8/10/04	19.47	23.08	3.61	7.63	10.02	2.39	84.9	115.5	7.64	8.45	0.81
8/11/04	18.79	23.17	4.38	7.16	9.84	2.68	77.0	113.7	7.47	8.51	1.04
8/12/04	18.79	23.10	4.31	7.10	9.83	2.73	76.9	113.7	7.51	8.59	1.08
8/13/04	18.66	20.79	2.13	7.06	8.42	1.36	76.7	90.3	7.54	7.78	0.24
13-DES-09.2											
8/9/04	19.40	20.18	0.78	7.85	8.87	1.02	85.0	97.5	7.26	7.51	0.25
8/10/04	17.84	21.06	3.22	7.47	9.59	2.12	79.6	105.7	7.18	7.79	0.61
8/11/04	18.01	21.15	3.14	7.40	9.53	2.13	79.1	104.9	7.17	7.76	0.59
8/12/04	18.10	21.19	3.09	7.37	9.53	2.16	79.0	105.3	7.16	7.80	0.64
8/13/04	17.85	19.72	1.87	7.42	8.75	1.33	78.9	92.2	7.12	7.48	0.36
13-DES-28.6											
8/9/04	19.46	20.65	1.19	6.67	7.72	1.05	72.3	85.6	6.91	7.11	0.20
8/10/04	17.42	21.51	4.09	6.52	9.11	2.59	70.8	101.1	6.89	7.62	0.73
8/11/04	17.45	21.49	4.04	6.25	9.04	2.79	68.7	100.4	6.86	7.60	0.74
8/12/04	17.62	21.57	3.95	6.17	8.74	2.57	66.9	97.7	6.81	7.60	0.79
8/13/04	17.53	19.99	2.46	6.13	7.43	1.30	66.0	77.6	6.82	7.36	0.54
13-DES-37.4											
8/10/04	16.63	20.66	4.03	8.53	10.85	2.32	93.0	114.4	7.50	8.15	0.65
8/11/04	15.75	20.81	5.06	8.37	10.94	2.57	91.4	114.1	7.48	8.17	0.69
8/12/04	16.09	20.85	4.76	8.28	10.51	2.23	89.9	110.1	7.52	8.28	0.76
8/13/04	15.96	19.18	3.22	8.31	9.86	1.55	89.1	99.4	7.51	7.65	0.14
13-CAP-00.0											
8/4/2004	18.96	22.57	3.61	8.67	11.53	2.86	102.5	132.9	8.62	9.86	1.24
8/5/2004	18.73	22.17	3.44	7.74	12.14	4.40	89.5	138.0	8.60	9.81	1.21
8/6/2004	18.63	21.76	3.13	7.82	11.43	3.61	90.1	127.9	8.55	9.55	1.00
8/7/2004	19.98	21.83	1.85	6.91	10.16	3.25	76.0	113.4	8.69	9.48	0.79
8/8/2004	19.69	22.69	3.00	7.40	12.11	4.71	81.2	137.9	8.48	9.71	1.23
8/9/2004	21.22	25.58	4.36	9.14	15.08	5.94	102.8	177.0	9.27	9.99	0.72
8/10/2004	21.96	25.37	3.41	9.68	15.82	6.14	110.4	192.2	9.33	10.24	0.91
8/11/2004	21.59	25.30	3.71	10.03	16.93	6.90	113.7	203.4	9.33	10.55	1.22
8/12/2004	22.62	24.81	2.19	10.47	16.28	5.81	120.9	194.9	9.57	10.32	0.75
8/13/2004	23.12	24.65	1.53	11.43	13.17	1.74	134.5	158.1	10.05	10.23	0.18

Table 9. Dry-weather fecal coliform levels within the Indian, Mission, and Moxlie Creek watersheds. (Data courtesy of City of Olympia and Thurston County.)

Sampling site	Site description	Date	Time	Fecal (org/100 mL)
Indian Creek watershed				
South Bay / 5th	end of driveway on eastside of So. Bay Rd at 5th	7/26/2004	10:00	1760
Martin	behind veterinary office	7/26/2004	10:05	3300
Boulevard	outlet of culvert under overpass	7/26/2004	10:20	255
Fredrick	down the stairs from treatment facility	7/26/2004	10:30	320
Wheeler	south side of road upstream of crossing	7/26/2004	10:50	330
Quince	gate at end of street	7/26/2004	11:00	390
Mission Creek watershed				
Ethridge	below road crossing	7/26/2004	11:10	470
Bethel	below road crossing	7/26/2004	11:20	265
East Bay Drive	upstream of road crossing	7/26/2004	11:30	113
Moxlie Creek watershed				
Eastside	surface - within Watershed Park	7/27/2004	12:00	67
Plum	surface - below confluence of Indian Creek	7/27/2004	11:40	500
8th	manhole	7/27/2004	11:30	2300
7th	manhole	7/27/2004	11:00	2400
Legion	manhole	7/27/2004	10:20	4400
5th	manhole	7/27/2004	10:10	4300
State (branch)	manhole - pipe trib to Moxlie	7/27/2004	9:55	300
mouth	directly from outfall pipe at low tide	7/27/2004	9:45	3800

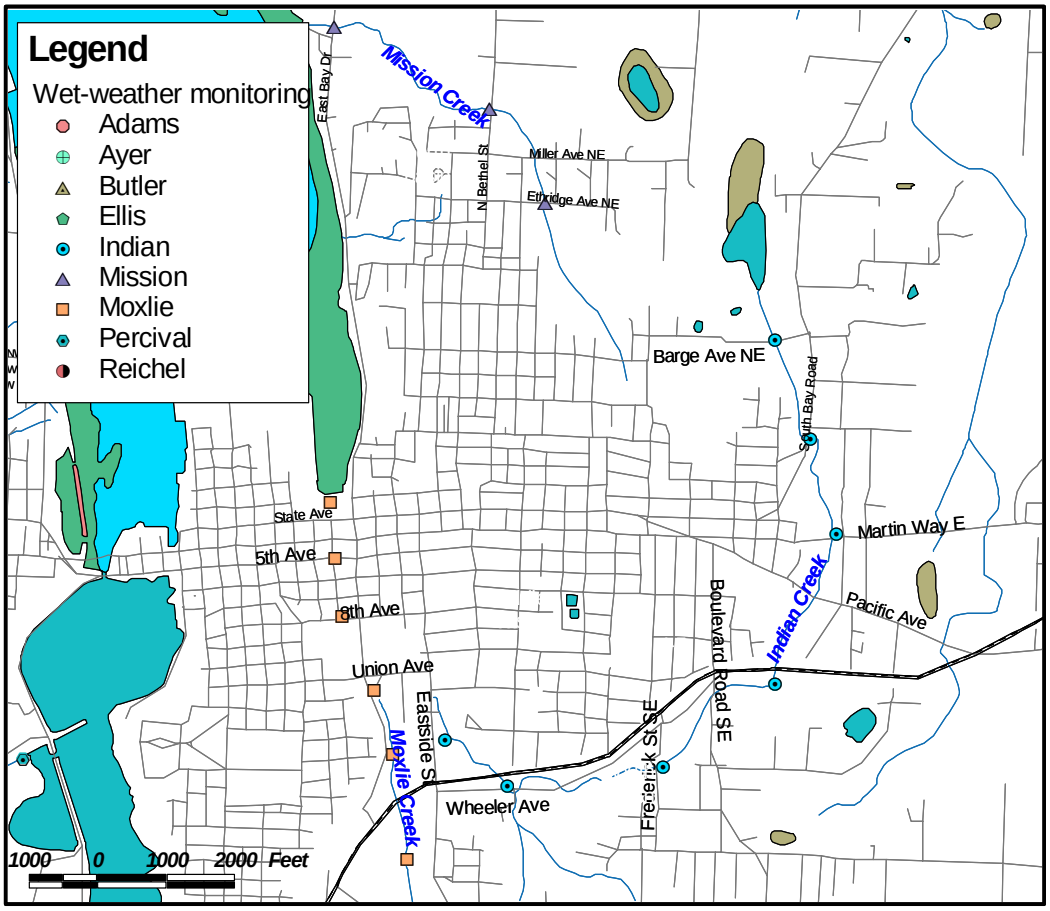


Figure 2. Fecal coliform monitoring locations within the Indian, Mission, and Moxlie Creek watersheds.

Table 10. Grab samples collected during Capitol Lake surveys. (September nutrient data not available from the laboratory at the time of publication.)

Date	Site	FC (#/100mL)	ALK (mg/L)	CHLORO (mg/L)	TSS (mg/L)	DOC (mg/L)	NH3 (mg/L)	NO23N (mg/L)	OP (mg/L)	TP (mg/L)	DTPN (mg/L)	TPN (mg/L)
7/13/2004	CL1	10	51	1.75	2	1.0	0.010	0.563	0.012	0.0227	0.645	0.685
	CL3	3	52	9.73		1.5	0.010	0.010	0.0052	0.0153	0.120	0.190
	CL4	2	51	9.47	4	1.4	0.010	0.010	0.0055	0.0158	0.110	0.170
8/18/2004	CL1	3	54.2	4.89	1	2.1	0.028	0.155	0.026	0.0504	0.296	
	CL3	1	54.7	112		2.4	0.010	0.010	0.005	0.0333	0.200	
	CL4	1	54.9	42	5	2.4	0.010	0.048	0.009	0.0247	0.190	
9/29/2004	CL1	35										
	CL3	9										
	CL4	4/5										

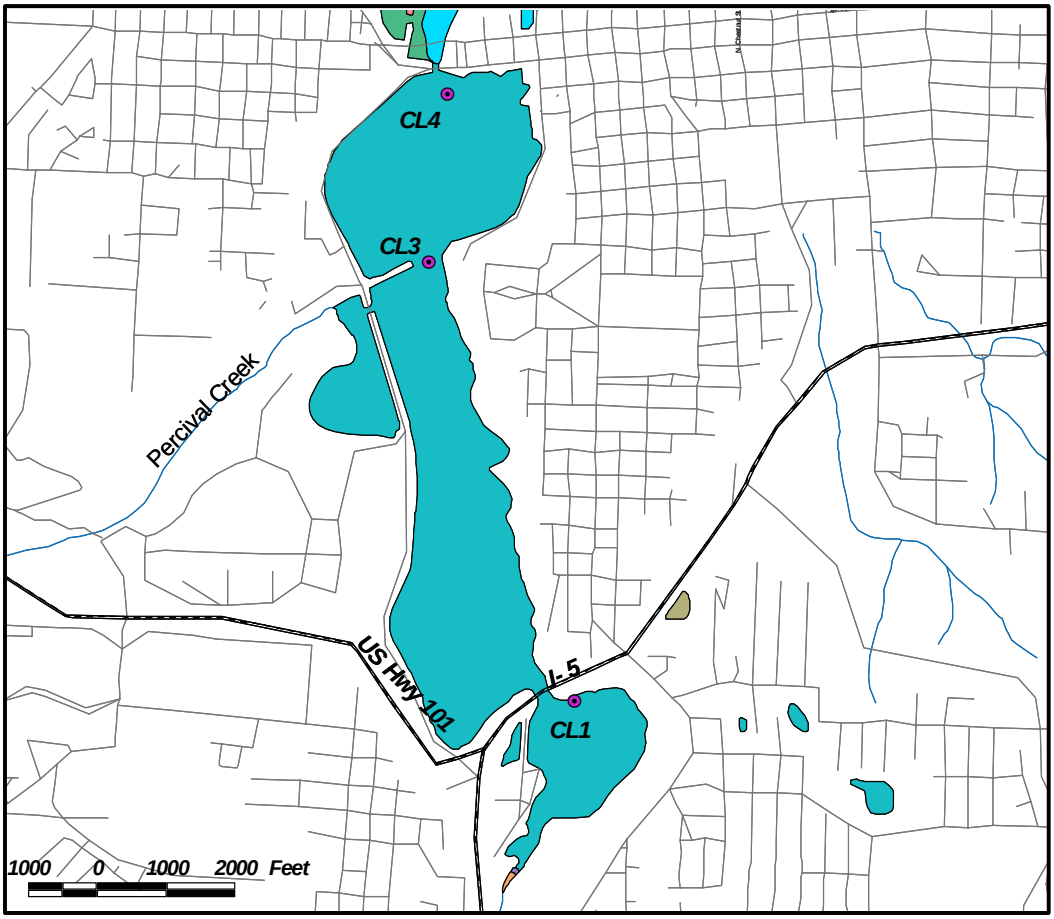
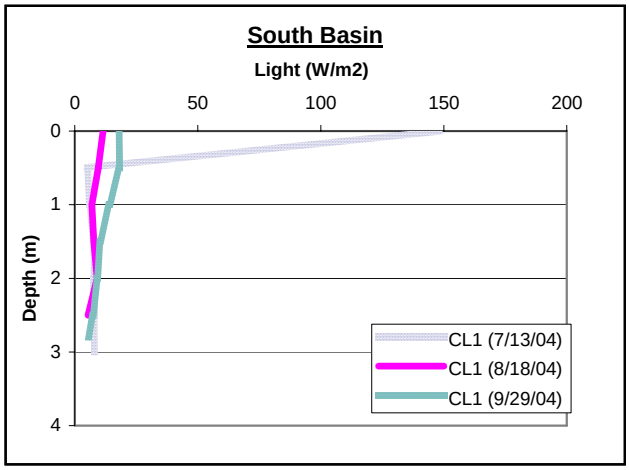
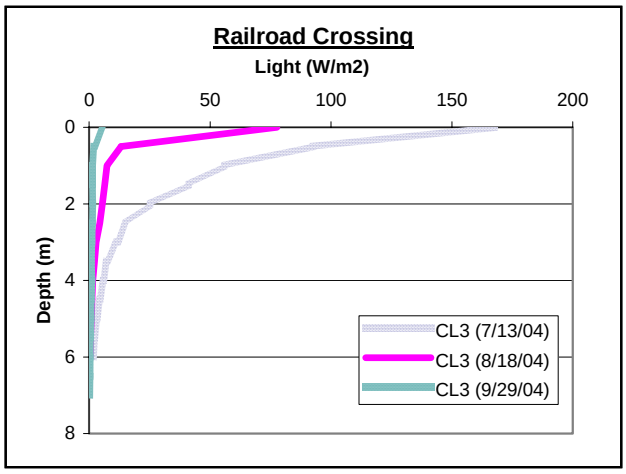


Figure 3. Capitol Lake monitoring stations for July through September (2004) surveys.

Table 11. Capitol Lake profiles of pH, temperature, and dissolved oxygen from July through September (2004) surveys. Highlighted values exceed 8.5 SU for pH, 18°C for temperature, or 110% saturation for dissolved oxygen, or are <10% saturation for dissolved oxygen.

Date	Time	Station	Depth (m)	Sp. Cond. (uS/cm)	pH (SU)	Temp (°C)	DO (mg/L)	DO% (%)
7/13/2004	12:25	CL1	0	77	8.3	18.5	10.65	110
			1	77	8.3	17.7	10.65	110
			2	76	8.5	16.9	10.75	111
			3	76	8.5	16.8	10.85	112
7/13/2004	13:15	CL3	0	110	9.4	23.0	12.10	142
			1	108	9.3	22.8	12.10	140
			2	88	8.7	19.9	10.90	120
			3	120	8.3	18.1	9.70	103
			4	7000	7.6	18.2	0.80	7
			5	8125	7.5	18.4	0.45	4
			5.5	8140	7.5	18.4	0.40	4
7/13/2004	13:50	CL4	0	108	9.4	22.6	12.55	146
			1	107	9.3	21.3	13.75	153
			2	118	9.0	19.1	12.10	130
			3	133	8.2	17.8	9.45	99
			4	222	8.1	17.7	8.20	86
			4.3	1000	7.7	18.0	7.50	72
8/18/2004	11:00	CL1	0	171	9.3	22.7	10.32	119
			1	149	7.9	18.0	8.76	92
			2	149	7.8	17.5	9.07	94
			2.5	148	7.8	17.5	9.16	95
8/18/2004	11:45	CL3	0	217	10.0	24.1	13.35	158
			1	179	9.0	22.6	9.38	108
			2	161	8.0	19.6	9.00	97
			3	7430	7.4	19.5	0.72	8
			4	10852	7.3	18.9	0.18	2
			5	10885	7.4	18.9	0.15	2
			5.5	10880	7.4	18.9	0.13	2
8/18/2004	12:15	CL4	0	215	10.0	23.9	13.29	157
			1	217	10.0	22.8	12.86	149
			2	186	8.2	20.7	9.22	102
			3	367	7.4	20.1	6.15	67
			4	8865	7.9	20.8	6.06	69
9/29/2004	14:45	CL1	0	132	7.9	13.3	10.71	103
			1	131	8.2	13.2	10.61	101
			2	131	8.2	13.1	10.54	100
			2.8	131	8.1	13.1	10.37	99
9/29/2004	14:05	CL3	0	167	8.7	15.2	11.46	114
			1	131	8.2	14.8	10.00	99
			2	150	8.1	14.4	9.50	93
			3	7347	7.4	14.8	7.61	77
			4	8279	7.3	14.8	7.00	71
9/29/2004	13:30	CL4	0	207	9.0	15.4	13.05	130
			1	232	8.8	15.3	12.28	122
			2	763	7.7	14.8	9.65	95
			3	9399	7.6	15.1	8.34	86
			4	17686	7.4	15.1	6.97	74





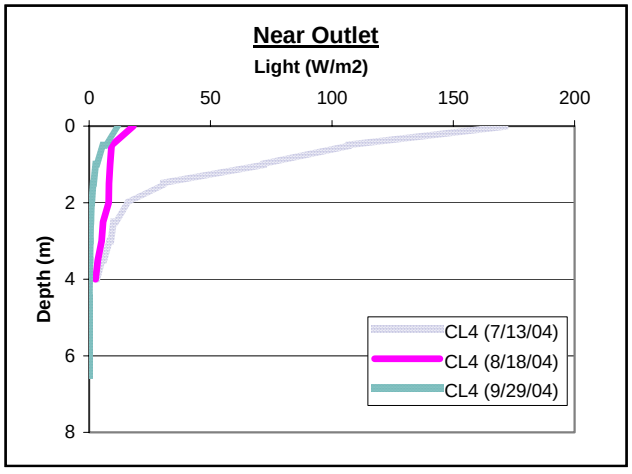


Figure 4. Capitol Lake light profiles from July through September (2004) surveys.

Table 12. Capitol Lake Secchi depth and grab samples of DO (Winkler titrations) during July through September (2004) surveys.

Date	Time	Station	Secchi Depth (m)	DO Winkler (mg/L)
7/13/2004	12:25	CL1	2.6	
	13:15	CL3	2.0	12.23
	13:50	CL4	1.6	
8/18/2004	11:00	CL1	NR	10.4
	11:45	CL3	NR	13.45
	12:15	CL4	NR	13.2/13.2
9/29/2004	14:45	CL1	1.9	11.9
	14:05	CL3	2	11.85
	13:30	CL4	1.26	14.0/15.0

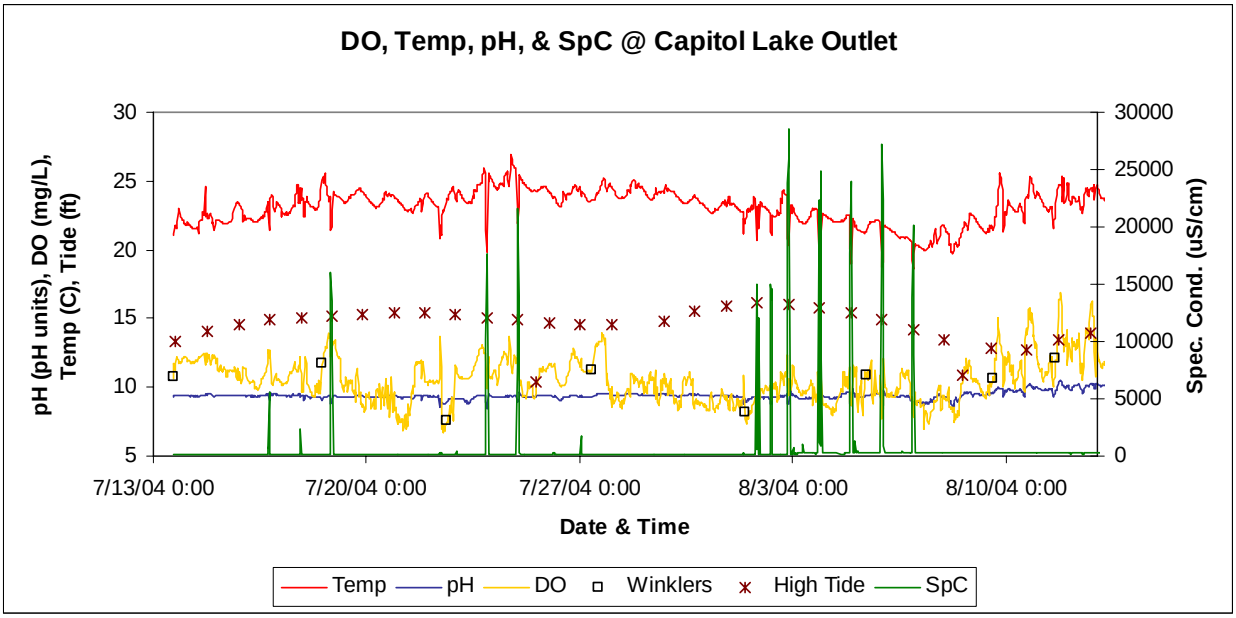


Figure 5. Continuous temperature, dissolved oxygen, pH, and specific conductance data for Capitol Lake near the outlet.

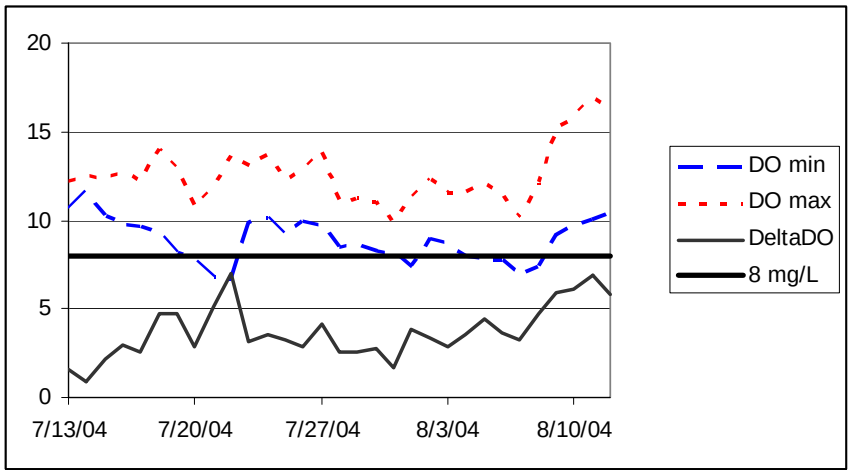


Figure 6. Daily minimum and maximum dissolved oxygen concentrations and the diel variation (DeltaDO) at the Capitol Lake outlet.

Table 13. Travel-time results for the Deschutes River, based on the dye study conducted August 2-6, 2004. Time of arrival of the peak concentrations are used to estimate velocity. Italics indicates dye release locations.

Location	River Mile	Cumulative		Differential	
		T (hr)	V (ft/s)	T (hr)	V (ft/s)
Vail Cutoff Rd	28.6	0.0			
USGS gage	24.9	11.8	0.46	11.8	0.46
SR507	20.6	25.3	0.46	13.5	0.22
Military Rd	19.1	29.7	0.47	4.3	0.51
Beans Rd	17.4	33.2	0.49	3.6	0.70
Waldrick Rd	14.5	39.9	0.52	6.7	0.63
Park at Cowlitz Dr	12.7	44.7	0.52	4.8	0.55
Rich Rd	9.6	52.9	0.53	8.2	0.56
Oly Fuel& Asphalt	6.8	59.9	0.53	7.0	0.59
Henderson Rd	2.7	71.2	0.53	11.3	0.53
E St. Bridge	0.5	75.8	0.54	4.7	0.69

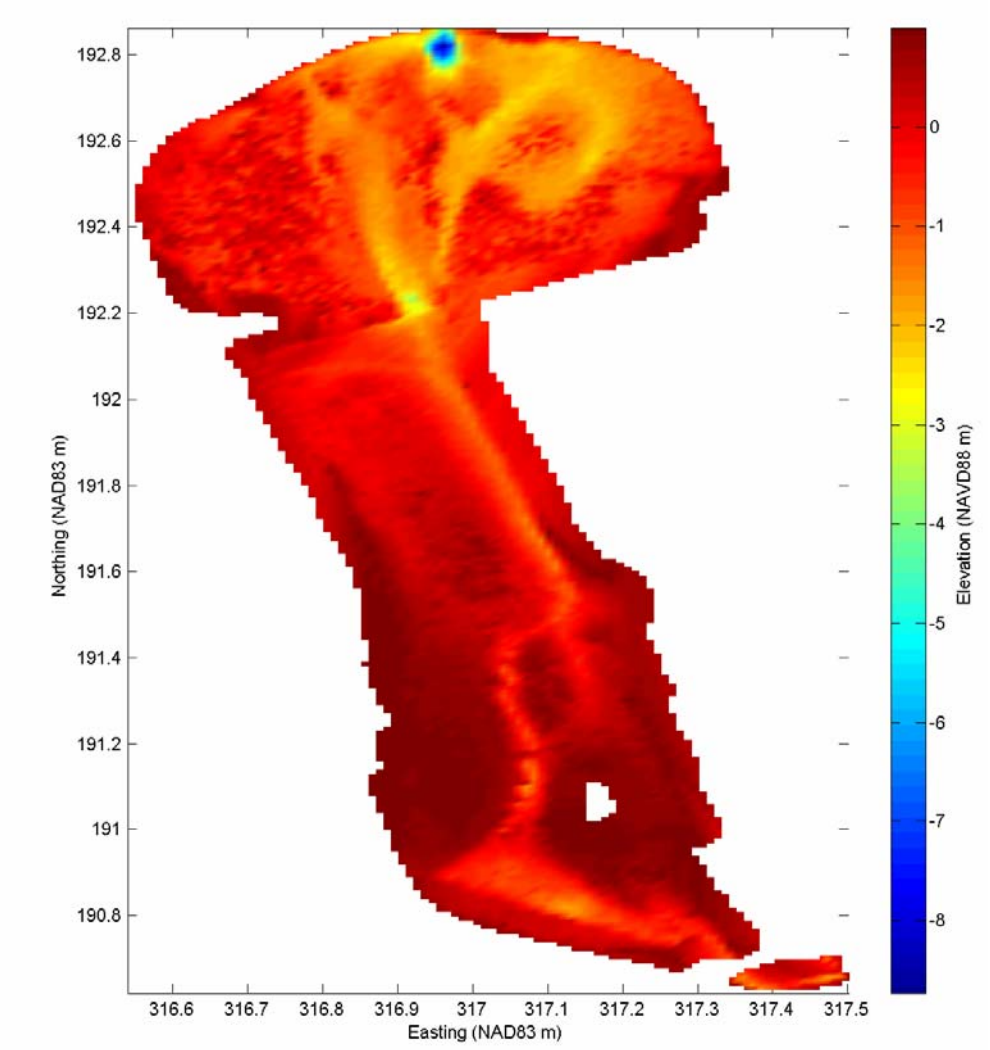


Figure 7. Preliminary bathymetric grid of Capitol Lake (north and middle basins).

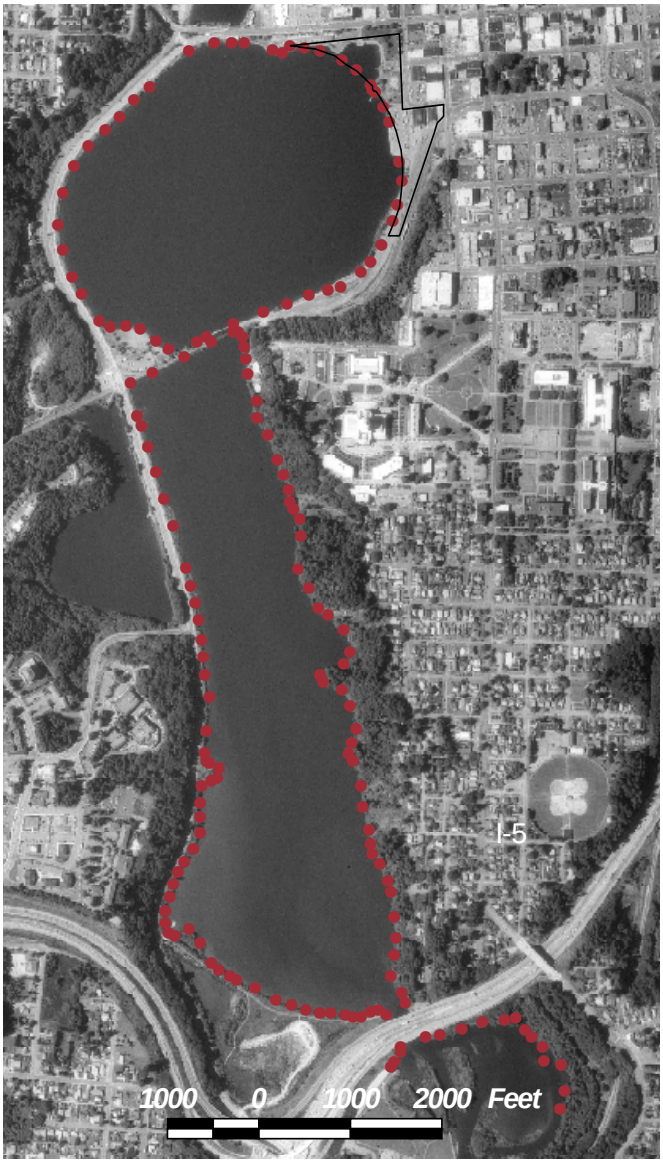


Figure 8. Shoreline mapped on September 23, 2004 by kayak with gps.

Table 14. Capitol Lake aquatic plant survey results for July 12-14, 2004.

Species	Common name	Frequency (% present)	Biomass* (g/m^2)
Myriophyllum spicatum	Eurasian milfoil	44	54.8
Elodea sp	waterweed	69	3.0
Ceratophyllum demersum	coontail	21	5.9
Nitella sp	stonewort	2	0.7
Potamogeton crispus	curly-leaf pondweed	5	0.04
Potamogeton sp	thin-leaf pondweed	29	0.8
(no plants)		20	0.0

*prior to herbicide application

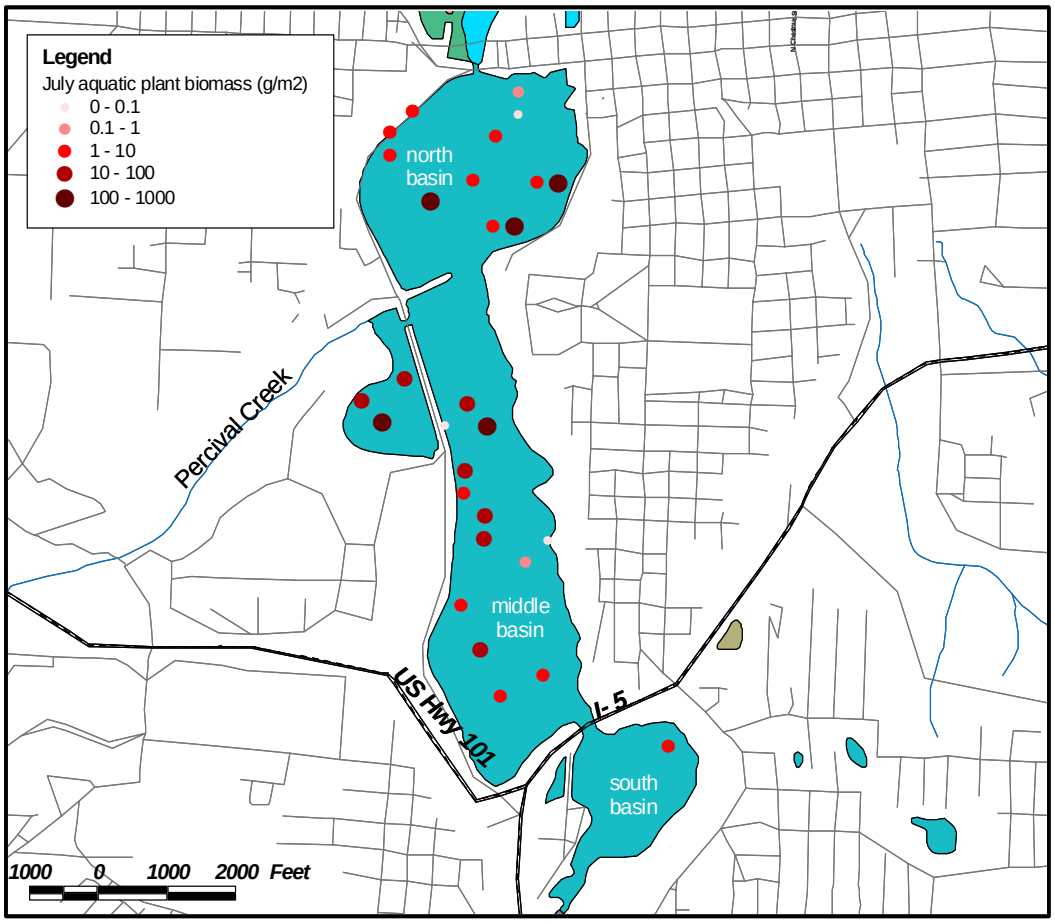


Figure 9. Capitol Lake aquatic plant biomass by sample location (July 12-14, 2004).